Use of Simple Organisms to Shed Light on Pain

We were very fortunate to have a session led by two scientists from the University of Southampton: Dr James Dillon from the School of Biological Sciences and Dr Chris Franks from the Faculty of Health Sciences.

The first half of the talk explained why some particular worms are suitable for studying the pain experienced by humans and the second half how they are used to study pain at a cellular level.

I have been tasked to summarise the talk in layman's terms, and so, with some help from Chris, here we go!

We saw a short video of a young man who was born with an inability to feel pain. His parents first noticed that there was a problem when, as a toddler, he chewed off half his tongue. They realised the severity of the issue when, as a teenager, he fractured his ankle, bound it up with duck tape and only thought to seek help at the end of the day. He was found to have been born with one protein missing that would normally be present in nerve cells and responsible for passing on pain messages to the rest of the nervous system. This illustrated both the importance of feeling pain to protect the body from harm and how studying abnormalities at a cellular level might shed light on pain management.

Humans are very complicated beings. Recent research has actually counted that we have 84 billion nerve cells and 36 billion support cells. We have supermassive connectivity and complexity making us tricky to study easily even without considering the ethical issues of inflicting pain on subjects in order to study its effects! So "model" organisms are needed to as alternatives.

Two organisms that are used in this type of research are the sea-slug Aplysia Californica and a nematode worm Caenorhabditis Elegans.
Aplysia has 20,000 nerve cells and has been shown to have a functional response to pain. This means that it feels pain and can learn to respond in an evasive way. In other words, despite being a much simpler organism with considerably fewer nerve cells, it behaves as we would. It is aware that something has hurt and it takes action to avoid it the next time. It has been found to contain similar proteins to those which are known to be involved in the pain pathways in humans.
C.Elegans is even more remarkable. C.Elegans is a non parasitic, microscopic worm about 1mm in length. It is different to the earthworm in that it is non-segmental and moves in a sinusoidal way, wiggles forwards in an 's' shape. It is transparent and so in specially prepared animals, it is possible to see the activity of individual nerve cells using a microscope. Most are hermaphrodite and exist in a state where normally 99.9% are female and 0.1% male. This led to that age old dilemma as to the use of the man at all, a question actually asked by a man at the meeting! Apparently the male adds to the gene pool and their numbers increase at times of stress so that the species can adapt to changes in its environment. Other facts that make it an ideal animal to study are that it has a 3 day life cycle, it has 4 larval stages that it can remain in if the circumstances are not favourable and it can be frozen for study at a later time. Worms frozen as early as 1972 have been successfully revived! It has only 302 nerve cells. The worm's genome, the total amount of genetic information in its DNA, is made up of 20,000 genes which is a very similar number to that of a human. Even more significantly, there is a 35% similarity in the genes responsible for maintaining basic life functions in both the worm and us. This make it an ideal model to study aspects of pain that might be relevant to humans.

There are lots of different levels at which pain can be investigated: physical, social, economical, psychological, emotional to name but a few. These researchers are using C.Elegans as a model to study pain at the cellular, ultrastructural level. Using genetic engineering which combines DNA from green algae and coral they can produce worms that react to blue light in a similar way to how they would react to a painful stimulus. In essence the 'pain' sensitive nerve network in the worm can be experimentally activated by remote control in the laboratory. These worms are hermaphrodite so many identical clones with this ability can be bred which is useful in the laboratory. They all demonstrate avoidance behaviour when the light is shone which provides the scientists with a useful tool to investigate the cellular function of the neuronal pain pathway in these organisms. We were given the chance to see this in the microscope that they brought along to the talk. When stimulated with a pulse of blue light the worms instantly reversed their direction of movement; the pain avoidance behaviour. These worms can be used to investigate the role of a particular group of protein called glutamate receptors which are involved in regulating the transmission of pain messages in the nervous system of humans. They are hoping that this type of research will go on to increase future understanding of pain pathways at a cellular level and ultimately help in the development of improved treatment for painful conditions.